Transmission of vibration from the instrument to the fingers during guitar playing

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Introduction

The physics of musical instruments has mostly focused on sound, highlighting how the mechanical vibrations in the instrument produce the sound and how this sound is perceived by the player and the audience. Music playing however involves sensory modalities beyond audition only. Electric guitar players for example are able to report on the tactile perception of their instrument during playing with a great precision (Cambourian et al. 2022). Vibrotactile cues are known to be used by players to evaluate the quality of their instrument (Fontana et al. 2017), or to have an effect on the perception of audio-related attributes (Wollman et al. 2014). Many questions remain, from the purely physical understanding of how the vibration is transmitted from the instrument to the body of the player, to how the player perceives the transmitted vibration, and to higher-level biomechanical concerns.

Methods

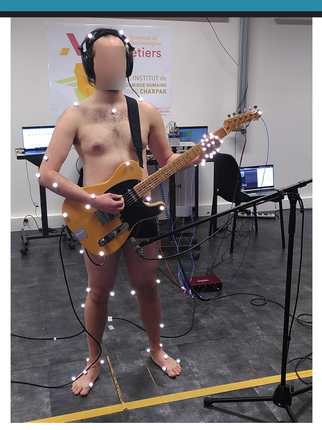

Fig.1 Experimental setup

Protocol

- One guitarist performed an E-mixolydian (3 repetitions) scale and a musical excerpt

Measurements

- Vibration transmissibility from the guitar to the hand (*accelerometers on the guitar's neck and the base of the 2nd and 3rd metacarpal bones*)
- Postural adjustments (activity of the left fingers and wrist muscles, optoelectronic system and force platforms) - *Not discussed here!*

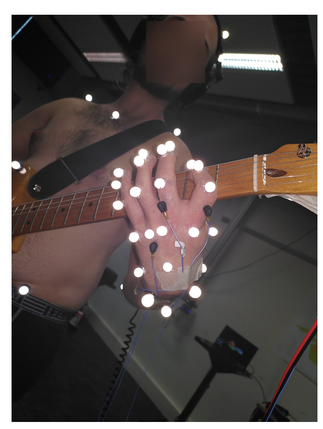

Fig.2 Focus on the left hand

Results

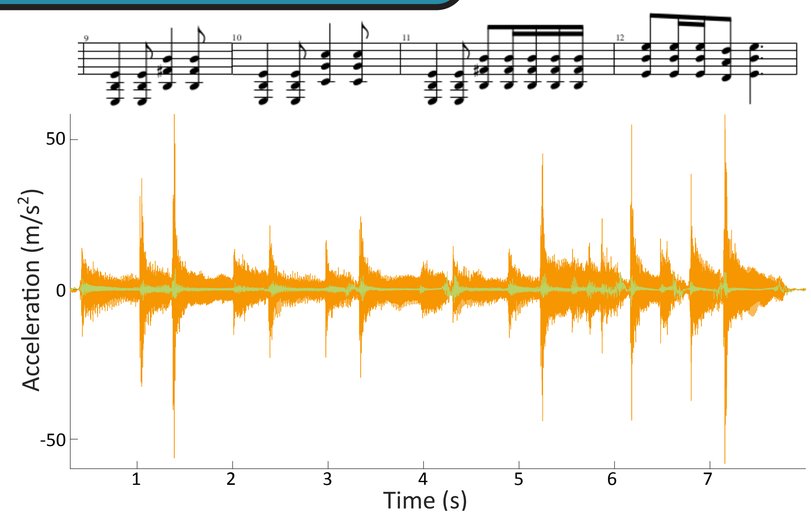

Fig.3 Acceleration measured at the guitar's neck (yellow curve) and base of the 2nd metacarpal bone (green curve) during a musical performance

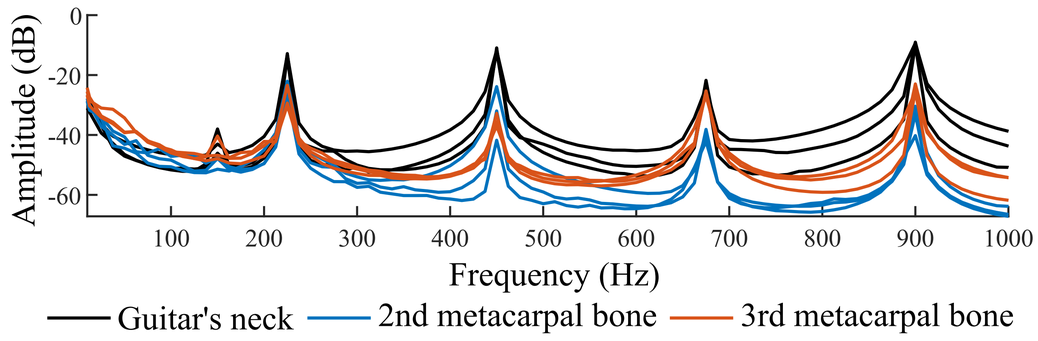

Fig.4 Acceleration spectra for note A3 (fretting finger = middle finger)

Take home messages:

- The vibration transmitted to the fingers is similar to the guitar neck's vibration
- The vibration content is transmitted up to 1000 Hz, i.e. the upper limit for vibro-tactile perception (Verrillo, 1992).

Discussion

- This study outlines that guitar players are physically receiving the musical information from the guitar. But what about their perception?
- A complementary study (Fig.5) investigates the transmissibility of vibration from the fingertip to each of the phalanxes (4 fingers, 2 pressing forces)
- Further works will address the perception of such vibration

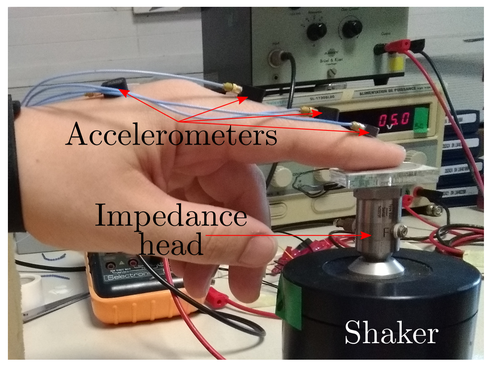

Fig.5 Measure of the vibration transmissibility throughout the finger

References

• Cambourian P, Paté A, Cance C, Navarret B, Vasseur J. 2022. Vocabulary to speak about touch: analysis of the discourse of electric guitar players. Acta Acust. 6(2):2. doi:10.1051/aacus/2021052. • Fontana F, Papetti S, Järveläinen H, Avanzini F. 2017. Detection of keyboard vibrations and effects on perceived piano quality. J Acoust Soc Am. 142(5):2953–2967. doi: 10.1121/1.5009659. • Verrillo RT. 1992. Vibration sensation in humans. Music Perception. 9(3):281–302. doi:10.2307/40285553. • Wollman I, Fritz C, Poitevineau J. 2014. Influence of vibrotactile feedback on some perceptual features of violins. J Acoust Soc Am. 136(2):910–921. doi:10.1121/1.4889865.